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Coronal approach to zygomaticomaxillary complex fractures

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Abstract. – OBJECTIVE: Trauma of the zygomaticomaxillary complex constitutes 45% of all midface fractures. In the author's medical unit, the proportion is 40% of all fractures of the facial skeleton. Most zygomaticomaxillary complex fractures can be treated via local incisions, however; multiple, comminuted and late fractures require wide exposure of the fragments in order to adequately reposition them and to apply rigid fixation.

PATIENTS AND METHODS: Thirty-one cases of comminuted or multiple fractures of the zygomaticomaxillary complex were treated with open reduction and rigid fixation by a coronal approach and analyzed for indications and postoperative complications. Twenty three patients had a hemi coronal approach and eight had a bicoronal approach.

RESULTS: Among the early complications noted were one case of hemorrhage, no infections, and two patients experienced paresthesia/ anesthesia in the supra orbital region, two patients in the temporal/parietal region, six patients experienced facial nerve weakness related to nerve retraction and moderate surgical edema was observed in three patients. Late complications included two cases of alopecia/baldness along the incision, one case of persistent paresthesia in the operative area. As far as the esthetics in relation to the incision was concerned, all patients were extremely satisfied.

CONCLUSIONS: The results of this study suggest that a coronal approach will facilitate accurate reduction and fixation of fragments and will allow good cosmetic result with minimal or no complications. The coronal incisions should be the first choice in case of comminuted, multiple and late zygomaticomaxillary complex fractures. However, indications for the use of coronal incisions must be strictly applied.

Key Words:
Coronal incision, Zygomatic complex fracture, Indications, Complications.

Introduction

The zygomaticomaxillary complex (ZMC) is a functional and aesthetic unit of the facial skeleton. Trauma of the zygomaticomaxillary complex constitutes 45% of all midface fractures[1]. In the authors' medical unit, the proportion is 40% of all fractures of the facial skeleton. The best surgical approach to treat fractures of the zygomatic complex must provide maximum necessary exposure of the fractured segments, minimize potential for injury to facial structures, and offer good cosmetic results. Views differ sharply as to which is the best surgical approach. Traditional closed techniques and total exposure of all fracture lines by multiple incisions[2] or routine coronal incision[3,4] compete with each other. Most zygomatic complex fractures can be treated via local incisions. However, when there are multiple, comminuted or late fractures, these require wide exposure of the fragments in order to adequately reposition them and apply rigid fixation.

In this study the coronal approach for treating comminuted or multiple fractures of the ZMC were evaluated in 31 patients. Advantages, indications and complications of the coronal approach were assessed.

Patients and Methods

Between June 2006 and July 2010, 31 patients treated by the authors for comminuted or multiple zygomaticomaxillary complex [ZMC] fractures were included in this study. An Institutional Ethical Committee approved the study and all patents provided written informed consent. Patients with diplopia or restriction in eye movements were excluded. There were 27 males and 4 females; their ages ranged from 14 to 55 years (mean 34 years). All the patients underwent preoperative radiological examinations using computed tomography views (Figures 1 and 2). Operations were carried out under general anesthesia using oral intubation in cases where nasal fractures were involved and nasal intubation when no nasal fractures were involved. All the 31 patients were operated on using

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Figure 1. The region of interests used to obtain the measurements on MRCP image.

the coronal approach, 23 with a hemicoronal incision and 8 with a bicoronal incision. Clinical evaluation included the number, type and duration of the complications following the surgical approach. The complications were divided into two categories, early and late[5,6]. Hemorrhage, hematoma, infection, edema, and nerve injury were classified as early complications, while alopecia, scarring , permanent paralysis of the facial nerve and depression of the temporal fossa were classified as long-term complications. The patients were followed-up at 1, 3, 6 months, 1 year and 3 years after operation. Occipito-mental, axial skull and submentovertex radiographs were obtained postoperatively to assess the position of the ZMC. Neurosensory deficits were examined using clinical examination (cold, light touch and two-point discrimination). The House-Brackman grading system (Table I) was used to assess facial nerve function postoperatively. Other complications were observed clinically. The Patient and Observer Scar Assessment Scale (Table II), was used to assess the resultant scar. All scars were assessed by three observers during the study. All observers were physicians who were regularly working with trauma patients. Each item has a 10-step score, whereby the score 10 reflects the worst imaginable scar or sensation. The total score of the observer scale consists of adding the scores of each of the five items (range, 5 to 50). The total score of the patient scale consists of adding the scores of each of the six items (range, 6 to 60). The lowest scores, 5 and 6, respectively, reflect normal skin. In addition to the scar assessment, the observers and the patients gave a general opinion on the appearance of the scar areas (score, 1 to 10, in which a score of 10 corresponds to the worst possible scar appearance).

Surgical Procedures

In a bicoronal incision, the incision began at the upper attachment of the helix and extended transversely over the vault of the skull to the opposite side. In case of balding males the incision was placed several centimeters behind the hairline from one preauricular line to the other (Figure 3) or even more posteriorly as suggested by Kerawala[7]. In females and non-balding males the incision was curved anteriorly at the vertex, paralleling but remaining 4-5 centimeters behind the hairline. In children the incision was placed well back in the hairline to allow for migration of the scar with growth. In case a hemicoronal incision was planned the incision was curved slightly forward at the vertex of the skull, following, but posterior to the hairline

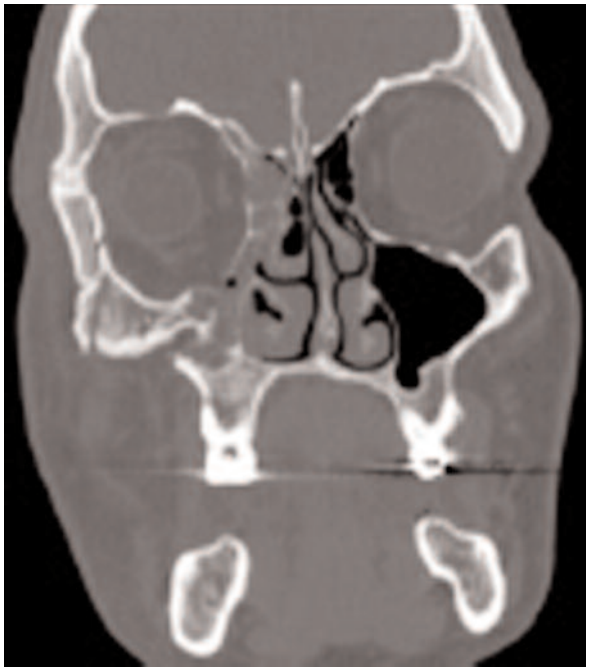

Figure 2. Axial CT scan showing right ZMC fracture with multiple fracture sites.

Table I. House Brackman grading system.

Grade	Description	Characteristics
I	Normal	Normal facial function in all nerve branches
II	Slight	Gross: Slight weakness on close inspection, slight synkinesis. At rest: Normal tone & symmetry. Motion: Forehead: Good to moderate movement. Eye: Complete closure with minimum effort. Mouth: Slight asymmetry.
III	Moderate	Gross: Obvious but not disfiguring facial asymmetry. Synkinesis is noticeable but not severe. May have hemi-facial spasm or contracture. At rest: Normal tone & symmetry. Motion: Forehead: Slight to moderate movement. Eye: Complete closure with effort. Mouth: Slight weakness with maximum effort.
IV	Moderately Severe	Gross: Asymmetry is disfiguring and/or obvious facial weakness. At rest: Normal tone & symmetry. Motion: Forehead: No movement. Eye: Incomplete eye closure. Mouth: Asymmetrical with maximum effort.
V	Severe	Gross: Only slight, barely noticeable, movement. At rest: Asymmetrical facial appearance. Motion: Forehead: No movement. Eye: Incomplete closure. Mouth: Slight movement.
VI	Total	No facial function

(Figure 4). Curving the hemicoronal incision forwards provided the relaxation necessary for retraction of the flap. The incision was extended preauricularly within a preauricular skin fold to the level of the lobule of the ear to provide access to the zygomatic arch. To assist in hemostasis a running 2-0 nylon [Ethicon] was inserted on the side of the suture line (Figure 3). The incision was marked with methylene blue ink. The area was infiltrated with 10-15 ml of 2% lidocaine containing 1:1,000,000 epinephrine [XICAINE, ICPA Health Products Ltd, Mumbai, India] into the subgaleal plane to promote hemostasis and to help separate the tissue layers. The initial portion of the incision was made with a number 10 blade and was limited to the area above the superficial temporal line to avoid incising through the temporal fascia into the temporalis muscle which would otherwise bleed freely. The incision was made through skin, subcutaneous tissue and galea revealing the subgaleal plane of loose areolar connective tissue overlying the pericranium. The flap margin was then lifted above the pericranium. Blunt dissection was carried out in the subgaleal space from above, toward the zygomatic arch with curved scissors and the overlying soft tissues were incised to that depth. After elevation of the flap margin for 1 to 2 cm, bleeding vessels were isolated, clamped with hemostats and cauterized. The periosteum was incised about 3 cm above the supraorbital ridges and the dissection was then completed subperiosteally. The supraorbital neurovascular bundles were released from their foramen in the bicoronal approach. Further subperiosteal dissection was completed inferiorly until the nasoethmoidal and nasofrontal sutures were exposed. The lateral dissection followed the outer surface of the *temporalis fascia* to approxi-

Table II. Patient and observer scar assessment scale.

	Observer component										
Normal skin	1	2	3	4	5	6	7	8	9	10	Worst scar imaginable
Vascularization											
Pigmentation											Hypo Mix Hyper
Thickness											
Relief											
Pliability											
Total Observer Score:											
	Patient component										
No, no complaints Is the scar painful? Is the scar itching?	1	2	3	4	5	6	7	8	9	10	Yes, worst imaginable
No, as normal skin Is the color of the scar different Is the scar more stiff Is the thickness of the scar different? Is the scar irregular?	1	2	3	4	5	6	7	8	9	10	Yes, very different
Total Patient Score:											

mately 2 cm above the zygomatic arch. At that point, where the temporal fascia splits into two layers[8] an incision running anterosuperiorly at 45^0 was made through the superficial layer of the temporalis fascia to spare the frontal branches of the facial nerve. This incision was connected anteriorly with the lateral or posterior limb of the supraorbital periosteal incision. Once a plane of dissection was established deep to the superficial layer of the temporal fascia, the dissection was continued inferiorly until the periosteum of the zygomatic arch was reached. The periosteum was then incised and reflected laterally over the arch, the body of zygoma, and the lateral orbital rim. Reflection of this and the periosteal flap of the supraorbital region provided exposure of the frontal bone, the upper part of the nose and the nasoethmoidal region; the roof, medial and lateral walls of the orbits, the zygomatic bone; and the entire zygomatic arch. Intraoral maxillary vestibular incision was added for exposure of the zygomaticomaxillary buttress. After reduction and fixation of the fragments (Figures 5, 6, 7) the periosteum and temporal fascia were "oversuspended" by suturing the cut inferior edge of the superficial layer of the temporal fascia 1 cm superior to the superior edge of the incised fascia. This was done to prevent droop-

Figure 3. Ransfixation sutures in place for a bicoronal flap.

Figure 4. Hemicoronal flap incision marked.

ing of the soft tissues in that region. Running horizontal 3-0 polyglactic acid sutures [Vicryl, Johnson and Johnson ltd, India] were used for this purpose. The galea was closed using 4-0 polyglactic acid sutures and the skin closure was achieved with 3-0 nylon [Ethilon, Johnson and Johnson Ltd, Hariana, India] sutures in the scalp region and 4-0 nylon sutures in the preauricular region. For the zygomaticomaxillary suture, a maxillary vestibular incision was made to complete the reduction and fixation of the ZMC. Vacuum suction drains were placed along with pressure dressings. The suction drains were removed in 24 to 48 hours. The skin sutures were removed in 7 to 10 days.

Results

Patients presented on average 12 hours after the trauma (3 hours-24 hours). In all patients (100%) the cause was road traffic accidents. Table III lists the distribution of associated fracture types and the corresponding approach used. Surgical blades were used in all patients to incise the scalp. The bicoronal approach was used in 8 cases whilst a hemicoronal incision was utilized in 23 cases. Complications in the early period included: 1 case with hemorrhage, no infections, 2 patients reported immediate postoperative supraorbital and supratrochlear nerve anesthesia or paraesthesia, 2 had immediate postoperative anesthesia or paraesthesia of the temporal/parietal region, 4 had Grade 3 injury of the facial nerve [House-Brackman Grading System], 2 patients had Grade 4 injury [House-Brackman Grading System][9] with complete clinical recovery observed in 4 weeks [Grade 1, Normal function] and 3 patients had moderate surgical edema. Three patients were lost to follow-up, so the numbers seen at different intervals were 31, 30, 29, 28,28 cases, respectively at the intervals 1-3 months, 6 months, 1 year, 2 years, 3 years. As to the long-term complications persistent paraesthesia was noted in 1 case (parietal and temporal region), depression of the temporal fossa was not observed in any case, and no patient had permanent palsy of the facial nerve (Table IV). The Patient and Observer Scar Assessment Scale[10] results were as follows: The total score of the observer scale in 28 patients was in the range of 10-14 [Range 5-50]. The total score of the patient scale in 28 patients was in the range 7-10 [Range 6-60]. The general patient and observer scar

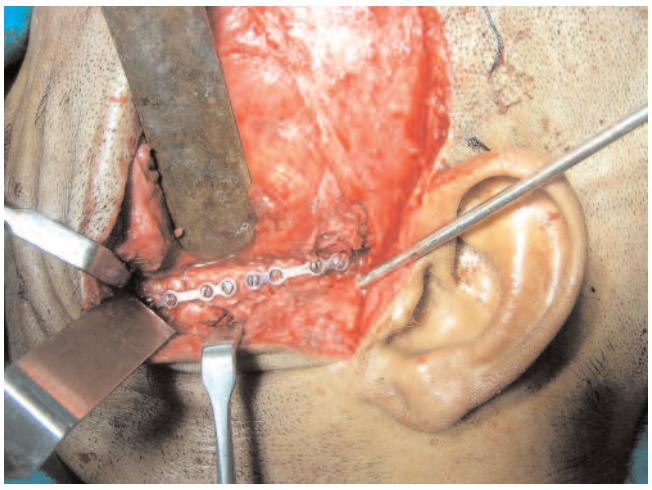

Figure 5. Rigid fixation of a comminuted right zygomatic arch fracture.

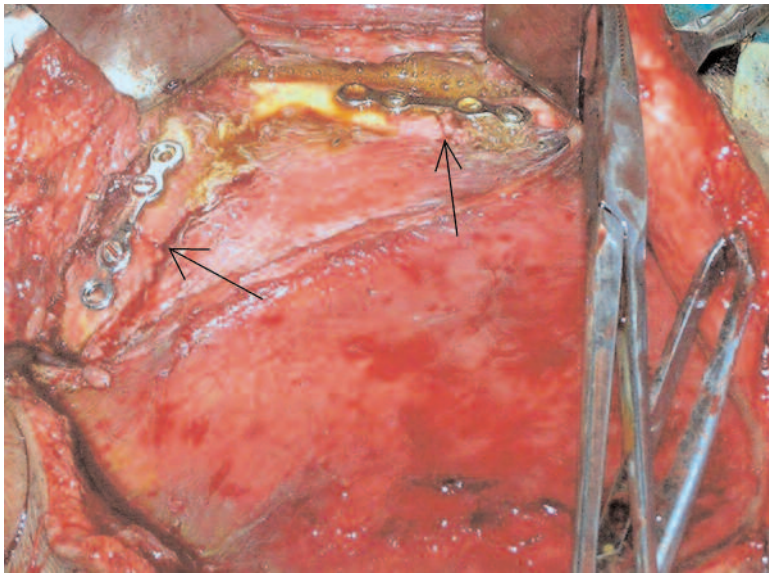

Figure 6. Rigid fixation of displaced left ZMC fracture.

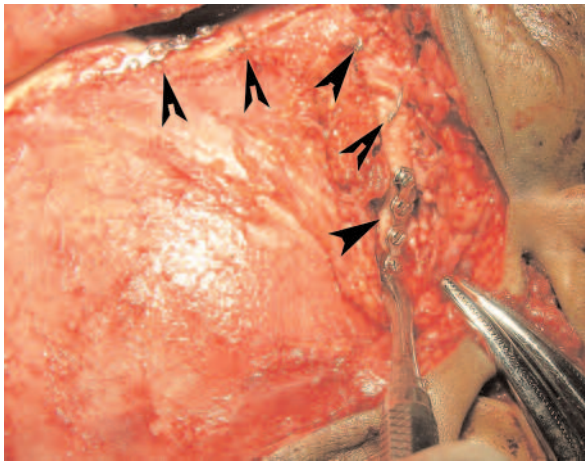

Figure 7. Rigid fixation of comminuted right ZMC fracture.

score was recorded as 2 by fifteen patients, 3 by eleven patients and 5 by two patients.

Discussion

Questions still remain about the best approach for reducing zygomatic complex fractures. A good access for easy reduction and fixation of the fractured segments is one of the customary essentials to treat zygomatic complex fractures. Some surgeons still favour percutaneous hook reduction in cases of fresh fractures[11], or use it in cases of less complex fractures[12], although it is known that rigid internal fixation offers better results and the traditional methods have a high rate of improper reduction and malunion[13,14]. Others prefer to expose the infraorbital rim and perform multiple osteosyntheses[15] or even expose all or nearly all fracture lines[16]. Gruss et al[3] suggest the coronal incision even in cases confined to the orbitozygomaticomaxillary region and to restore the zygomatic arch using miniplates and screws.

The approaches used for treating zygomatic complex fractures can be divided into two categories: local and coronal incisions. Local incisions are preferred in most Western countries[15,18]. Concepts of various authors differ with respect to the use of different approaches to treating zygomaticomaxillary complex fractures. Coronal incisions were used previously in craniofacial surgery[19], orthopaedic surgery[6], and head and neck cancer surgery[12] and are still used in trauma surgery[18]. Lo-

Table III. Types of associated fractures in 31 patients approached by coronal incisions.

Types of fractures	Number of patients	Approach used
Additional fractures	8	Bicoronal
Comminuted fractures	08	Hemicoronal
Simple fractures of the zygomatic	06	Hemicoronal
Zygomatic arch only	03	Hemicoronal
Late fractures	06	Hemicoronal
Total	**31**	

Table IV. Complications following the coronal approach noted during follow-up.

Time (no. of cases reviewed)	1-3 months (31)	6 months (30)	1 yr (29)	2 yr (28)	3 yr (27)
Complications					
Soft tissue infection	0	0	0	0	0
Paraesthesia/anesthesia of supraorbital region	2	0	0	0	0
Haemorrhage/haematoma	1	3	0	0	0
Swelling	0	0	0	0	0
Ptosis	0	0	0	0	0
Alopecia/baldness	2	2	2	2	2
Depression at temporal fossa	0	0	0	0	0
Paresis of facial nerve	6	0	0	0	0
Paraesthesia/Anesthesia of parietal or temporal region	2	1	1	1	1
Total	**16**	**3**	**3**	**3**	**3**

cal incisions were preferred by 71% of surgeons in a survey conducted among British maxillofacial surgeons[17]. Kovacs and Ghahremani[1] also suggested a preference for local incisions in their study. In this study, coronal incisions were applied in 31 cases. The approach differs from Western practices since most of the fractures in this series were caused by high speed traffic accidents leading to severe, multiple or comminuted fractures, for which local incisions generally do not facilitate full exposure and accurate reduction.

Clinically, coronal incisions offer an advantage over local incisions by virtue of their ability to provide complete visualization of a major part of the zygomaticomaxillary complex. Bone plating and grafting can be accomplished in congruence where indicated. The coronal approach also provides the surgeon with an opportunity to harvest cranial bone through the same incision when immediate bone grafting is indicated and, therefore, eliminates the morbidity associated with a second donor site[5].

At our Unit, the absolute indications for coronal incisions for treating zygomatic complex fractures are: (1) Multiple fractures of zygomatic complex with other midfacial/frontal bone fractures; (2) Comminution of the ZMC; (3) Old fractures of the ZMC with malunion or nonunion. (4) Zygomatic arch fracture with multiple fragments or inferior displacement [unstable arch].

Relative indications are displaced fractures of the zygoma in patients who do not wish to have periorbital facial incisions.

The best time to treat midfacial fractures is considered to be as early as possible[16,20]. Patients in this study were operated upon 3 days (on average) after the trauma. This interval also allows the amelioration of swelling and haematoma, which might hinder palpatory control of surgical reduction.

Regarding early complications following coronal incisions Frodel and Marentette (1993)[4] as well as Abubaker et al (1990)[21] recognized hematoma, hemorrhage, nerve injury, infection and edema. In order to prevent hematoma/hemorrhage (seen in 1 patient), continuous transfixation along the line of incision, local anesthetic including adrenaline injected under the galea aponeurotica, electric coagulation and ligation of arteries were performed during the operation whenever necessary. Soft tissue infections were not observed in this series as all patients were placed on broad spectrum antibiotics and scrupulous care of the incision line was maintained postoperatively. Nerve complications were always related to original injury and traction on the nerve. In this group, two patients complained of a transient sensory deficit of the supraorbital and supratrochlear nerves which resolved within one month. Two patients complained of sensory deficit in the parietal/temporal region. Six patients had some difficulty in forehead wrinkling and eyelid function which were related to injury of the facial nerve (temporal and zygomatic branches). All patients recovered full function within 4 weeks. To prevent any injury to the nerves concerned, the temporal fascia was incised 1 cm above the zygomatic arch root, and the flap developed along the deep fascia, so that the temporal and zygomatic branches were kept

in the skin flap for protection. Moderate surgical edema was observed in three patients and could be the result of over pleased flap retraction and presence of severe comminution in the ZMC. The edema disappeared by the third to fifth postoperative day in all cases.

As to the long-term complications (6 months to 3 years postoperatively), one patient complained of persistent hypoesthesia in the operative area which did not affect any of his routine activities. Two patients recorded a score of 5 on the general scar assessment score based on the resultant alopecia along the scar. However, the area was well hidden within the hairline. Alopecia could be related to use of the cautery for hemostasis along the flap edges suggesting that apart from electric coagulation, hair follicles were destroyed leading to a wide scar. Therefore, it would be wise not to use the electrocautery excessively, incisions should be parallel to the hair follicles and an excellent closure in layers should follow. Burm and Oh (1999)[22] described the wedge scalp incision, which preserved deep hair follicles to prevent a wide scar and could grow new hair within the incision area after suture. The patient and observer scar scores were both indicative of a very satisfactory scar outcome in the other 26 patients.

Conclusions

Most ZMC fractures can be treated via local incisions. However, coronal incisions may still be considered the first choice in cases of comminuted, multiple or late fractures and when associated fractures of the frontal/nasoethmoidal bones are present. The results of this study suggest that a coronal approach will allow an unhindered exposure of the ZMC to facilitate accurate reduction and fixation of the fracture fragments. This approach has the added advantage of cosmetic results with minimal or no postsurgical complications. However this approach must be used only for cases where it is indicated.

Acknowledgements

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Conflict of Interest

The Authors declare that they have no conflict of interests.

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